CLAIMS

1. A tunable microwave/millimeter-wave arrangement comprising a tunable impedance surface,
c h a r a c t e r i z e d i n
that it comprises an Electromagnetic Bandgap Structure (EBG) (Photonic Bandgap Structure) comprising at least one tunable ferroelectric layer, at least one first, top, metal layer and at least one second metal layer, said first and second metal layers being disposed on opposite sides of the/a ferroelectric layer, and in that at least the first, top, metal layer is patterned and in that the dielectric permittivity of the at least one ferroelectric layer is dependent on a DC biasing voltage applied directly or indirectly to first and/or second metal layers disposed on different sides of the/a ferroelectric layer.

2. An arrangement according to claim 1,
c h a r a c t e r i z e d i n
that at least the first patterned metal layer is so patterned as to form/comprise an array of radiators.

3. An arrangement according to claim 2,
c h a r a c t e r i z e d i n
that the radiators comprise resonators.

4. An arrangement according to claim 3,
c h a r a c t e r i z e d i n
that the resonators comprise patch resonators.

5. An arrangement according to claim 4,
c h a r a c t e r i z e d i n

that the patch resonators are circular, square shaped, rectangular or of any other appropriate shape.

6. An arrangement according to any one of claims 2-5, c h a r a c t e r i z e d i n that the radiators, e.g. the resonators, are arranged in a two-dimensional (2D) array, forming a 2D array antenna, e.g. with a square, rectangular, triangular or any other appropriate grid layout of the patches.

7. An arrangement according to claim 6, c h a r a c t e r i z e d i n that it comprises a reflective antenna.

8. An arrangement according to any one of claims 6 or 7, c h a r a c t e r i z e d i n that the radiators of the first, top, metal plane are galvanically connected, by means of via connections through the ferroelectric layer with a further second metal plane and in that a DC biasing voltage is applied to said first metal plane indirectly over said further second metal plane.

9. An arrangement according to claim 8, c h a r a c t e r i z e d i n that the second metal layer is patterned, and comprises openings or holes allowing the via connections pass to said further, or additional, bottom, second metal layer which may be patterned or not, and in that the DC biasing (control) voltage is applied between the two second metal layers to vary the impedance of the (top) radiator array, and thus the resonant frequency of the resonator.

10. An arrangement according to claim 9,
c h a r a c t e r i z e d i n
that the via connections are connected to the center points of the radiators where the RF microwave current is highest.

11. An arrangement according to any one of claims 7-10,
c h a r a c t e r i z e d i n
that the radiator spacing in the top layer is approximately 0.1 cm $\approx \lambda_0/30$, λ_0 being the free space wavelength of incident microwave signals.

12. An arrangement according to any one of claims 7-11,
c h a r a c t e r i z e d i n
that by varying the DC control (bias voltage) the impedance of the array of radiators can be changed from inductive to capacitive, reaching infinity at the resonant frequency of the radiators (resonators).

13. An arrangement according to any one of claims 7-12,
c h a r a c t e r i z e d i n
that the (top) array of radiators comprises substantially 20 x 20 radiators and in that the dielectric permittivity $\varepsilon(V)$ of the ferroelectric layer varies between approximately 225-200 or lies between 50-n x 10000, n beeing an integer, the ferroelectric layer having a thickness of about 50 μm.

14. An arrangement according to any one of claims 1-6,
c h a r a c t e r i z e d i n
that radiators are arranged in at least two 2D arrays, comprising said first and second metal layers between which the ferroelectric layer is disposed and in that it comprises a transmission type array, e.g. a transmission antenna.

15. An arrangement according to claim 14,
c h a r a c t e r i z e d i n
that dielectric or ferroelectric layers are provided on the sides of the first and second metal layers, i.e. the radiator (resonator) arrays, which are not in contact with said ferroelectric layer.

16. An arrangement according to claim 14 or 15,
c h a r a c t e r i z e d i n
that a DC voltage is applied to the metal layers, and in that the same DC voltage is provided to each individual radiator for changing the dielectric permittivity of the ferroelectric film and hence the resonant frequency of the radiators.

17. An arrangement according to claim 16,
c h a r a c t e r i z e d i n
that it comprises a wavefront phase modulator for changing the phase of a transmitted microwave signal.

18. An arrangement according to claim 14 or 15,
c h a r a c t e r i z e d i n
that the radiators of the arrays are individually DC voltage biased, i.e. that the DC voltage applied to each radiator is controllable, or settable, by means of impedance means.

19. An arrangement according to claim 18,
c h a r a c t e r i z e d i n
that i comprises a beam scanning antenna.

20. An arrangement according to claim 18 or 19,
c h a r a c t e r i z e d i n
that separate DC voltage dividers are connected to the radiators, one in x-direction for the radiators of one metal plane and one in

the y-direction in order for the radiators of another metal plane to allow for non-uniform voltage distribution in the x-, and y-direction respectively, thus allowing a tunable, non-uniform modulation of the microwave signal phase front.

21. An arrangement according to claim 20,
c h a r a c t e r i z e d i n
that the impedances comprise resistors.

22. An arrangement according to claim 20,
c h a r a c t e r i z e d i n
that the impedance comprise capacitors.

23. An arrangement according to claim 21 or 22,
c h a r a c t e r i z e d i n
that each radiator is separately and individually connected to a DC biasing voltage over a separate resistor/capacitor.

24. An arrangement according to any one of claims 14-23,
c h a r a c t e r i z e d i n
that the thickness of the ferroelectric layer(s) is between about 1μm- several mm and in that the DC biasing voltage ranges from 0 - several kV.

25. An arrangement according to any one of claims 1-5, 14-24,
c h a r a c t e r i z e d i n
that the first and second metal layers comprise a number of radiators respectively, wherein the radiators of the first and the second layer have different configuration and/or are differently arranged.

26. An arrangement according to claim 25,
c h a r a c t e r i z e d i n

that different coupling means are provided for the radiators of said first and second layer respectively.

27. An arrangement according to claim 25 or 26,
c h a r a c t e r i z e d i n
that a DC biasing (control voltage) is applied to the radiators of said first and second metal layers to change the lumped capacitance and hence the capacitive (weak) coupling between the radiators, e.g. patch resonators.

28. An arrangement according to any one of the claims 14-27,
c h a r a c t e r i z e d i n
that the tunable radiator arrray(s) is/are integrated with a waveguide horn such that by changing the DC bias voltage the horn will scan a microwave beam or modulate the phase in space of a microwave signal.

29. An arrangement according to any one of the preceding claims,
c h a r a c t e r i z e d i n
that the spacing between adjacent radiators (e.g. resonators) corresponds to a factor about 0 - 1.5 times the wavelength of an incident/microwave signal in the ferroelectric layer.

30. An arrangement according to any one of claims 1-5,
c h a r c t e r i z e d i n
that it comprises a 3D tunable radiator array, e.g. used as a filter, duplexor etc.

31. Use of an arrangement according to any one of claims 1-30, for controlling microwave/(sub)millimeter wave signals in free space or cavity waveguides for changing the phase and/or amplitude distribution of the signals reflected and/or transmitted through it.